

Amendments to the Claims

This listing of claim will replace all prior versions and listings of claim in the application.

1 1. (currently amended) An integrated circuit comprising:
2 a control circuit to generate a first control signal according to a phase relationship between
3 an input signal and a first clock signal;
4 a select circuit coupled to receive the first control signal from the control circuit and
5 coupled to receive a second control signal, the select circuit being responsive to a
6 select signal to select ~~either~~ from one of the first control signal ~~or~~ and the second
7 control signal to be output as a selected control signal; and
8 a phase adjust circuit coupled to receive the selected control signal from the select circuit,
9 the phase adjust circuit being responsive to the selected control signal to adjust the
10 phase of the first clock signal.

1 2. (previously presented) The integrated circuit of claim 1 further comprising a receive
2 circuit to sample the input signal in response to the first clock signal.

1 3. (currently amended) The integrated circuit of claim 1 wherein the phase adjust circuit
2 includes circuitry to output a plurality of clock signals including the first clock signal, and
3 wherein the control circuit comprises:
4 a receive circuit to capture a plurality of samples of the input signal in response to
5 transitions of the plurality of clock signals; and
6 a phase control circuit to determine, based on the plurality of samples of the input signal,
7 whether a transition of the input signal occurs before a transition of the first clock signal
8 and ~~or~~ whether the transition of the input signal occurs after a ~~the~~ transition of the
9 first clock signal.

1 4. (currently amended) The integrated circuit of claim 3 wherein the first control signal is a
2 digital signal having one of at least two possible states, and wherein the phase control
3 ~~signal circuit~~ includes circuitry to output the first control signal in a state selected from one
4 of in either a first state ~~or~~ and a second state of the at least two possible states based, at
5 least in part, on whether the transition of the input signal occurs before the transition of the

6 first clock signal and ~~or~~ whether the transition of the input signal occurs after the transition
7 of the first clock signal.

1 5. (previously presented) The integrated circuit of claim 1 wherein the first control signal
2 includes a first component signal that is asserted when the first clock signal lags the input
3 signal and a second component signal that is asserted when the first clock signal leads the
4 input signal.

1 6. (previously presented) The integrated circuit of claim 1 wherein the first control signal is
2 an analog signal having a voltage level indicative of the phase relationship between the
3 input signal and the first clock signal.

1 7. (previously presented) The integrated circuit of claim 1 wherein the first control signal is
2 an analog signal having a current level indicative of the phase relationship between the
3 input signal and the first clock signal.

1 8. (previously presented) The integrated circuit of claim 1 further comprising an input to
2 receive the select signal from an external device.

1 9. (currently amended) The integrated circuit of claim 1 further comprising a programmable
2 register to store a mode value, the select signal having ~~either~~ from one of a first state ~~or~~ and
3 a second state according to the mode value, and the select circuit including a circuitry to
4 select the first control signal when the select signal is in the first state and to select the
5 second control signal when the select signal is in the second state.

1 10. (previously presented) The integrated circuit of claim 1 wherein the select circuit
2 comprises a multiplexer circuit.

1 11. (currently amended) A method of operation within an integrated circuit, the method
2 comprising:
3 determining a phase relationship between an input signal and a first clock signal;
4 generating a first control signal according to the phase relationship between the input signal

5 and the first clock signal;
6 selecting ~~either~~ from one of the first control signal ~~or~~ and a second control signal to be
7 output to a phase adjust circuit as a selected control signal; and
8 adjusting, in the phase adjust circuit, a phase of the first clock signal according to the
9 selected control signal.

1 12. (previously presented) The method of claim 11 further comprising sampling the input
2 signal in response to the first clock signal.

1 13. (currently amended) The method of claim 11 further comprising:
2 outputting a plurality of clock signals, including the first clock signal;
3 capturing a plurality of samples of the input signal in response to transitions of the plurality
4 of clock signals; and
5 determining the phase relationship between the input signal and the first clock signal, at
6 least in part, by determining, based on the plurality of samples of the input signal,
7 whether a transition of the input signal occurs before a transition of the first clock
8 signal and ~~or~~ whether the transition of the input signal occurs after a the transition of
9 the first clock signal.

1 14. (currently amended) The method of claim 13 wherein generating the first control signal
2 comprises generating a digital control signal having one of at least two possible states
3 based, at least in part, on whether the transition of the input signal occurs before the
4 transition of the first clock signal and ~~or~~ whether the transition of the input signal occurs
5 after the transition of the first clock signal.

1 15. (previously presented) The method of claim 11 wherein generating the first control signal
2 comprises generating a digital signal having a first and second component signals, the first
3 component signal being asserted when the first clock signal lags the input signal and the
4 second component signal being asserted when the first clock signal leads the input signal.

1 16. (previously presented) The method of claim 11 further comprising receiving the selected
2 control signal from a device that is external to the integrated circuit.

1 17. (previously presented) The method of claim 11 further comprising storing a mode value in
2 a programmable register within the integrated circuit, and wherein generating the selected
3 control signal comprises generating the selected control signal according to the mode
4 value.

1 18. (previously presented) The method of claim 11 further comprising
2 receiving a command to store a mode value; and
3 storing the mode value in a register within the integrated circuit; and
4 wherein generating the selected control signal comprises generating the select signal
5 according to the mode value.

1 19. (currently amended) An integrated circuit device comprising:
2 a first clock data recovery (CDR) circuit to recover clock and data signals from a first
3 signal line, the first CDR circuit including:
4 a first phase control circuit to generate a first control signal, and
5 a first phase adjust circuit to adjust the phase of a first recovered clock signal in
6 response to the first control signal; and
7 a second CDR circuit to recover clock and data signals from a second signal line, the
8 second CDR circuit including:
9 a second phase control circuit to generate a second control signal,
10 a select circuit coupled to receive the first and second control signals and being
11 responsive to a select signal to select ~~either~~ from one of the first control signal
12 ~~or and~~ the second control signal to be output as a selected control signal, and
13 a second phase adjust circuit to adjust the phase of a second recovered clock signal in
14 response to the selected control signal.

1 20. (currently amended) The integrated circuit device of claim 19 wherein the select circuit
2 comprises a multiplexer circuit having a control input coupled to receive the ~~selected~~
3 ~~control~~ select signal and having respective input ports coupled to receive the first and
4 second control signals from the first and second phase control circuits.

1 21. (currently amended) The integrated circuit device of claim 19 further comprising
2 additional CDR circuits each having a respective phase control circuit, select circuit and
3 phase adjust circuit, the select circuit of each of the additional CDR circuits being
4 responsive to a control input to output, as a selected control signal, ~~either~~ from one of the
5 first control signal ~~or~~ and a phase control signal output by the phase control circuit of the
6 additional CDR circuit, the phase adjust circuit of each of the additional CDR circuits
7 being responsive to the selected control signal output by the select circuit for the additional
8 CDR circuit to adjust the phase of a respective recovered clock signal.

1 22. (previously presented) The integrated circuit device of claim 19 wherein the first CDR
2 circuit further includes a first receive circuit to sample an input signal on the first signal
3 line in response to the first recovered clock signal, and the second CDR circuit further
4 includes a second receive circuit to sample an input signal on the second signal line in
5 response to the second recovered clock signal.

1 23. (previously presented) The integrated circuit device of claim 19 further comprising an
2 input to receive the select signal from an external device.

1 24. (currently amended) The integrated circuit device of claim 19 further comprising a
2 programmable register to store a mode value, the select signal having ~~either~~ from one of a
3 first state ~~or~~ and a second state according to the mode value, and the select circuit including
4 a circuitry to select the first control signal when the select signal is in the first state and to
5 select the second control signal when the select signal is in the second state.

1 25. (previously presented) The integrated circuit device of claim 19 wherein the select circuit
2 is responsive to the select signal to disable generation of the first control signal when the
3 select signal indicates that the select circuit is to select the second control signal to be
4 output as the selected control signal.

1 26. (currently amended) A method of controlling an integrated circuit, the method comprising:
2 outputting a first command to the integrated circuit to set a first clock data recovery (CDR)

3 circuit within the integrated circuit to a first mode, the first CDR circuit including a
4 select circuit to select a first control signal to adjust the phase of a first clock signal
5 when the first CDR circuit is in the first mode;
6 delaying for a first time interval; and
7 outputting, after the first time interval, a second command to the integrated circuit to set the
8 first CDR circuit to a second mode, the select circuit of the first CDR circuit ~~being~~
9 ~~adapted~~ to select a second control signal when the first CDR circuit is in the second
10 mode, the second control signal being generated by a second CDR circuit.

1 27. (previously presented) The method of claim 26 wherein delaying for the first time interval
2 comprises delaying until a predetermined number of cycles of a clock signal have
3 transpired.

1 28. (previously presented) The method of claim 26 wherein outputting the first command to
2 the integrated circuit to set the first CDR circuit to the first mode comprises outputting a
3 command to the integrated circuit to store a mode value in a programmable register within
4 the integrated circuit, the mode value indicating the first mode.

1 29. (previously presented) The method of claim 26 wherein outputting the first command to
2 the integrated circuit to set the first CDR circuit to the first mode comprises outputting a
3 mode signal to the integrated circuit, the mode signal being input to a select input of the
4 select circuit to select the first control signal.

1 30. (previously presented) The method of claim 26 further comprising periodically repeating
2 the outputting the first command to the integrated circuit, delaying for the first time
3 interval, and outputting the second command to the integrated circuit.

1 31. (previously presented) The method of claim 26 further comprising:
2 detecting a predetermined condition; and
3 in response to the detecting the predetermined condition, repeating the outputting the first
4 command to the integrated circuit, delaying for the first time interval, and outputting
5 the second command to the integrated circuit.

- 1 32. (previously presented) The method of claim 31 wherein the detecting the predetermined
2 condition comprises detecting a change in temperature.
- 1 33. (previously presented) The method of claim 31 wherein the detecting the predetermined
2 condition comprises detecting a change in voltage.
- 1 34. (previously presented) The method of claim 31 wherein the detecting the predetermined
2 condition comprises detecting a loss of synchronization between the first clock signal and a
3 data signal received in the first CDR circuit.
- 1 35. (currently amended) A system comprising:
2 a first signal line;
3 a receive device coupled to the first signal line, the receive device having a first clock data
4 recovery (CDR) circuit to recover clock and data signals from the first signal line, the
5 first CDR circuit including a control circuit, a select circuit and a phase adjust circuit,
6 the control circuit ~~being adapted~~ to generate a first control signal according to a phase
7 relationship between an input signal on the first signal line and a first clock signal, the
8 select circuit being responsive to a first mode value to select ~~either~~ from one of the
9 first control signal ~~or~~ and a second control signal to be output as a selected control
10 signal, the phase adjust circuit ~~being adapted~~ to adjust the phase of the first clock
11 signal according to the selected control signal; and
12 a control device coupled to the receive device to provide the first mode value ~~thereto~~.
- 1 36. (previously presented) The system of claim 35 wherein the control device is coupled to
2 provide the first mode value to the receive device via the first signal line.
- 1 37. (currently amended) The system of claim 35 further comprising at least one additional
2 signal line, the at least one additional signal line ~~being~~ coupled to the receive device and to
3 the control device, the control device ~~being adapted~~ to provide the first mode value to the
4 receive device via the at least one additional signal line.

1 38. (currently amended) The system of claim 35 wherein the control device ~~is adapted~~ to
2 output the first mode value to the receive device and then, after a first time interval, to
3 output a second mode value to the receive device, the select circuit being responsive to the
4 first mode value to select the first control signal to be output as the selected control signal,
5 the select circuit being responsive to the second mode value to select the second control
6 signal to be output as the selected control signal.

1 39. (previously presented) The system of claim 38 further comprising a second signal line
2 coupled to the receive device, and wherein the receive device includes a second CDR
3 circuit to recover clock and data signals from the second signal line, the second CDR
4 circuit including a control circuit to generate the second control signal according to a phase
5 relationship between an input signal on the second signal line and a second clock signal.

1 40. (previously presented) The system of claim 35 wherein the receive device is implemented
2 in a first integrated circuit and the control device is implemented in a second integrated
3 circuit.

1 41. (previously presented) The system of claim 40 wherein the first and second integrated
2 circuits are packaged in separate integrated circuit packages.

1 42. (previously presented) The system of claim 40 wherein the first and second integrated
2 circuits are packaged in the same integrated circuit package.

1 43. (previously presented) The system of claim 35 wherein the receive device and the control
2 device are implemented within a single integrated circuit.

1 44. (cancelled)

1 45. (currently amended) A method of testing an integrated circuit (IC) that includes a clock
2 data recovery (CDR) circuit and a phase control port, the method comprising:
3 outputting a ~~first~~ command to the IC to set the CDR circuit to a ~~first~~ mode of operation, the

4 CDR circuit having a select circuit that responds to the ~~first~~ mode of operation by
5 selecting the phase control port to source a control signal instead of a phase control
6 circuit within the CDR circuit, the control signal ~~being~~ used by a phase adjust circuit
7 within the CDR circuit to adjust the phase of a ~~first~~ clock signal;
8 outputting a phase control signal to the phase control port of the integrated circuit device to
9 adjust the phase of the ~~first~~ clock signal; and
10 wherein outputting the first command to the integrated circuit to set the CDR circuit to the
11 ~~first~~ mode of operation comprises outputting a command to the integrated circuit to
12 store a mode value in a programmable register within the integrated circuit, the mode
13 value indicating the ~~first~~ mode of operation.

1 46. (cancelled)

1 47. (currently amended) A method of testing an integrated circuit (IC) that includes a clock
2 data recovery (CDR) circuit and a phase control port, the method comprising:

- 3 a. outputting a ~~first~~ command to the IC to set the CDR circuit to a ~~first~~ mode of operation, the
4 CDR circuit having a select circuit that responds to the ~~first~~ mode of operation by
5 selecting the phase control port to source a control signal instead of a phase control
6 circuit within the CDR circuit, the control signal ~~being~~ used by a phase adjust circuit
7 within the CDR circuit to adjust the phase of a ~~first~~ clock signal;
8 b. asserting a phase control signal at the phase control port of the integrated circuit for a first
9 predetermined time interval, the phase adjust circuit within the CDR circuit ~~being~~
10 responsive to the phase control signal to adjust the phase of the ~~first~~ clock signal;
11 c. deasserting the phase control signal for a second predetermined time interval; and
12 d. measuring the ~~first~~ clock signal with a signal measuring device while repeating ~~steps b and~~
13 ~~e~~ asserting a phase control signal and deasserting the phase control signal at least
14 until the phase of the ~~first~~ clock signal has progressed through a predetermined
15 portion of a cycle of the ~~first~~ clock signal.

1 48. (currently amended) The method of claim 47 wherein the predetermined portion of a cycle
2 of the ~~first~~ clock signal is an entire cycle of the ~~first~~ clock signal.

1 49. (currently amended) The method of claim 47 wherein the phase adjust circuit responds to
2 assertion of the control signal by advancing the phase of the ~~first~~ clock signal.

1 50. (currently amended) The method of claim 47 wherein the first predetermined time interval
2 is selected to allow the phase adjust circuit to advance the phase of the ~~first~~ clock signal by
3 a predetermined phase angle.

1 51. (currently amended) The method of claim 47 wherein measuring the ~~first~~ clock signal with
2 a signal measuring device comprises measuring the ~~first~~ clock signal with an oscilloscope.

1 52. (currently amended) An integrated circuit device comprising:
2 a first signal generator to generate a first test signal;
3 a receive circuit having an input switchably coupled to receive the first test signal from the
4 first signal generator, the receive circuit including circuitry responsive to a first clock
5 signal to capture samples of the first test signal;
6 a clock data recovery (CDR) circuit having a control circuit, a select circuit and a phase
7 adjust circuit, the control circuit ~~being adapted~~ to generate a first control signal based
8 on the samples of the first test signal, the select circuit ~~being~~ responsive to a select
9 signal to select ~~either from one of~~ the first control signal ~~or and~~ a second control
10 signal to be output as a selected control signal, and the phase adjust circuit ~~being~~
11 responsive to the selected control signal to adjust the phase of the first clock signal;
12 and
13 a compare circuit to compare the samples of the first test signal to a compare signal.

1 53. (previously presented) The integrated circuit device of claim 52 wherein the first signal
2 generator is a linear feedback shift register and the first test signal is a pseudo random bit
3 sequence.

1 54. (currently amended) The integrated circuit device of claim 52 further comprising a
2 transmit circuit having an input and an output, the input of the transmit circuit ~~being~~
3 switchably coupled to receive the first test signal from the first signal generator, and the

output of the transmit circuit ~~being~~ switchably coupled to the input of the receive circuit.

55. (previously presented) The integrated circuit device of claim 52 further comprising a mode control circuit to store a mode value indicative of an operating mode of the integrated circuit device, the mode control circuit outputting a test mode signal when the mode value is indicative of a test mode of operation, the test mode signal switching the input of the receive circuit to be coupled to receive the first test signal.

56. (previously presented) The integrated device of claim 52 wherein the compare circuit includes a second signal generator to generate the compare signal.

57. (previously presented) The integrated circuit device of claim 56 wherein the first signal generator and the second signal generator are designed to generate identical signals.

58. (previously presented) The integrated device of claim 52 wherein the first signal generator is coupled to provide the first test signal to the compare circuit, the compare signal being the first test signal.

59. (currently amended) A method of testing an integrated circuit that includes a clock data recovery (CDR) circuit and a phase control port, the method comprising:

~~a.~~ setting the CDR circuit to a test mode in which a select circuit within the CDR circuit selects the phase control port to source a control signal instead of a phase control circuit within the CDR circuit, the control signal ~~being~~ used by a phase adjust circuit within the CDR circuit to adjust the phase of a first clock signal;

~~b.~~ inputting a test signal to a receiver of the CDR circuit;

~~c.~~ comparing the test signal against samples of the test signal generated by the CDR circuit;

~~d.~~ asserting an error signal when the test signal does not match the samples;

~~e.~~ asserting a phase control signal at the phase control port to adjust the phase of the first clock signal; and

~~f.~~ repeating steps c through e comparing the test signal, asserting an error signal and asserting a phase control signal to determine a maximum phase and a minimum phase of the first clock signal for which the error signal is not asserted.